Nano 2020: Scaling up nanotechnology in virtual reality

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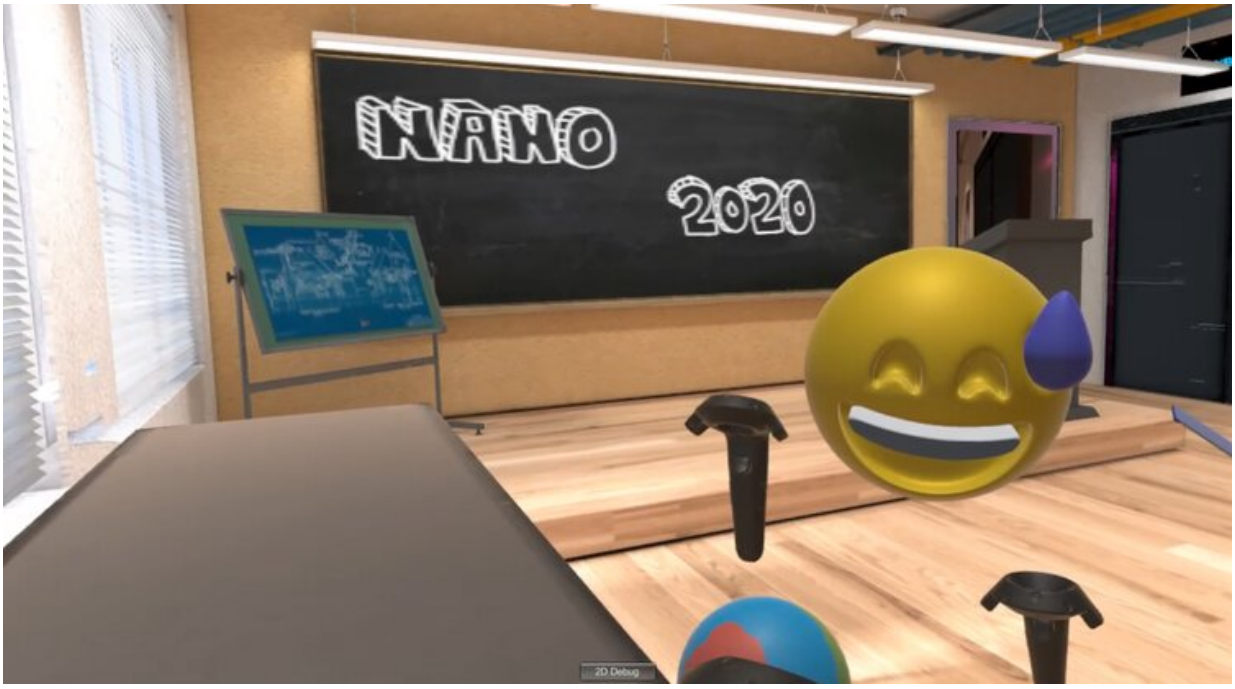

"Just imagine you have scientists who are engineers in a nanotechnology area and you have agriculture students, and the only way to really have them come together would be to fly or have a teleconference. We can eliminate that barrier and connect people virtually through this virtual reality hub," said Nano 2020 principal investigator Randy Burd. Credit: University of Arizona

Sometimes the smallest of things lead to the biggest ideas. Case in point: Nano 2020, a University of Arizona-led initiative to develop curriculum

and technology focused on educating students in the rapidly expanding field of nanotechnology.

The five-year, multi-university project recently met its goal of creating globally relevant and implementable curricula and instructional technologies, to include a virtual reality classroom, that enhance the capacity of educators to teach students about innovative nanotechnology applications in agriculture and the life sciences.

Visualizing What is Too Small to be Seen

Nanotechnology involves particles and devices developed and used at the scale of 100 nanometers or less—to put that in perspective, the average diameter of a human hair is 80,000 nanometers. The extremely small scale can make comprehension challenging when it comes to learning about things that cannot be seen with the naked eye.

That's where the Nano 2020 virtual reality classroom comes in. In a custom-developed VR classroom complete with a laboratory, nanoscale objects come to life for students thanks to the power of science data visualization.

Within the VR environment, students can interact with objects of nanoscale proportions—pick them up, turn them around and examine every nuance of things that would otherwise be too small to see. Students can also interact with their instructor or their peers. The Nano 2020 classroom allows for multi-player functionality, giving educators and students the opportunity to connect in a VR laboratory in real time, no matter where they are in the world.

"The virtual reality technology brings to life this complex content in a way that is oddly simple," said Matt Mars, associate professor of agricultural leadership and innovation education in the College of

Agriculture and Life Sciences and co-director of the Nano 2020 grant. "Imagine if you can take a student and they see a nanometer from a distance, and then they're able to approach it and see how small it is by actually being in it. It's mind-blowing, but in a way that students will be like, 'Oh wow, that is really cool!'"

The technology was developed by Tech Core, a group of student programmers and developers led by director Ash Black in the Eller College of Management.

"The thing that I was the most fascinated with from the beginning was playing with a sense of scale," said Black, a lifelong technologist and mentor-in-residence at the McGuire Center for Entrepreneurship. "What really intrigued me about virtual reality is that it is a tool where scale is elastic—you can dial it up and dial it down. Obviously, with nanotechnology, you're dealing with very, very small things that nobody has seen yet, so it seemed like a perfect use of virtual reality."

Black and Tech Core students including Robert Johnson, Hazza Alkaabi, Matthew Romero, Devon Oberdan, Brandon Erickson and Tim Lukau turned science data into an object, the object into an image, and the image into a 3-D rendering that is functional in the VR environment they built.

"I think that being able to interact with objects of nanoscale data in this environment will result in a lot of light bulbs going off in the students' minds. I think they'll get it," Black said. "To be able to experience something that is abstract—like, what does a carbon atom look like—well, if you can actually look at it, that's suddenly a whole lot of context."

The VR classroom complements the Nano 2020 curriculum, which globally expands the opportunities for nanotechnology education within

the fields of agriculture and the life sciences.

Teaching the Workforce of the Future

"There have been great advances to the use of nanotechnology in the health sciences, but many more opportunities for innovation in this area still exist in the agriculture fields. The idea is to be able to advance these opportunities for innovation by providing some educational tools," said Randy Burd, who was a nutritional sciences professor at the University of Arizona when he started the Nano 2020 project with funding from a National Institute of Food and Agriculture Higher Education Challenge grant through the United States Department of Agriculture. "It not only will give students the basics of the understanding of the applications, but will give them the innovative thought processes to think of new creations. That's the real key."

Unknown Object

The goal of the Nano 2020 team, which includes faculty from the University of Arizona, Northern Arizona University and Johns Hopkins University, was to create an online suite of undergraduate courses that was not university-specific, but could be accessed and added to by educators to reach students around the world.

To that end, the team built modular courses in nanotechnology subjects such as glycobiology, optical microscopy and histology, nanomicroscopy techniques, nutritional genomics, applications of magnetic nanotechnology, and design, innovation, and entrepreneurship, to name a few. An online library will be created to facilitate the ongoing expansion of the open-source curricula, which will be disseminated through novel technologies such as the virtual reality classroom.

"It isn't practical to think that other universities and colleges are just

going to be able to launch new courses, because they still need people to teach those courses," Mars said. "So we created a robust and flexible set of module-based course packages that include exercises, lectures, videos, power points, tools. Instructors will be able to pull out components and integrate them into what already exists to continue to move toward a more comprehensive offering in nanotechnology education."

According to Mars, the highly adaptable nature of the curriculum and the ability to deliver it in various ways were key components of the Nano 2020 project.

"We approach the project with a strong entrepreneurial mindset and heavy emphasis on innovation. We wanted it to be broadly defined and flexible in structure, so that other institutions access and model the curricula, see its foundation, and adapt that to what their needs were to begin to disseminate the notion of nanotechnology as an underdeveloped but really important field within the larger landscape of agriculture and life sciences," Mars said. "We wanted to also provide an overlay to the scientific and technological components that would be about adoption in human application, and we approached that through an innovation and entrepreneurial leadership lens."

Portions of the Nano 2020 curriculum are currently being offered as electives in a certificate program through the Department of Agriculture Education, Technology and Innovation at the University of Arizona. As it becomes more widely disseminated through the higher education community at large, researchers expect the curriculum and VR classroom technology to transcend the boundaries of discipline, institution and geography.

"An online open platform will exist where people can download components and courses, and all of it is framed by the technology, so that these experiences and research can be shared over this virtual reality

component," Burd said. "It's technologically distinct from what exists now."

"The idea is that it's not just curriculum, but it's the delivery of that curriculum, and the delivery of that curriculum in various ways," Mars said. "There's a relatability that comes with the virtual reality that I think is really cool. It allows students to relate to something as abstract as a nanometer, and that is what is really exciting."

Provided by University of Arizona